

KNOWLEDGE MANAGEMENT

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Anecdotes

Origami

I have before me paper models of a unicorn, a stegasaurus, and a giraffe. Each was folded from a single square sheet of paper without any cutting or pasting. What is the value of these figures? The paper involved is a few pennies. I consumed .10 pizzas while folding them. Yet they are much more valuable than that. Why?

I added *knowledge*. I obtained the knowledge from books written by John Montroll in Maryland, who created the knowledge. He has the incredible ability to see an animal, understand its proportions, and recognize how to convert a square piece of paper into a figure that represents that animal. After he created the knowledge, he transmitted it via books.¹ I then acquired the knowledge and used it to produce the models.

Stuff we know

My brain contains a lot of stuff I don't really (or rarely) need:

- ALTER TABLESPACE SYSTEM ADD DATAFILE . . .
- Exit 12 off the New Jersey Turnpike will take you to Carteret.
- //SYSIN DD *
- A runway number is the runway's heading minus the right digit.
- You used to IPL a computer instead of re-booting it.
- You can transfer from the 6 train to the B, D, or F train at Bleeker Street only if you are going downtown.
- . . .

My work

For ten years I lived in the corporate world. I was an employee interested in materials planning techniques, and I became more knowledgeable about these than anyone in any of the companies where I worked. However, in each case, corporate politics prevented me from propagating the ideas and my inability to deal with politics prevented me from advancing in these companies.

When I joined Oracle, the working relationship was now between me and my client. As long as I produced good work, my client (and I) was happy. My boss and the corporate structure was completely irrelevant. I liked that.

The Internet

Every day, I get a few more notes on my "Data Management mailing list". Not all of them are of equal value, but they give me a very good window on what many people are thinking about. Where in the old days, my acquaintances would have been limited to people in my home town, now I am casually hearing from people all over the world – people who have exactly the same concerns that I do.

I have a web page on which I have, among other things, posted the articles I have presented to ODTUG, IOUW, and others, as well as the ones I have written for magazines and journals. Each month the number of hits grows. (In March 800 people visited.) I get periodic reports that reveal that these people are from Singapore, Thailand, The Netherlands, Brazil, Estonia, and dozens of other places around the world. Occasionally I get e-mail from a reader, saying that she likes an article and has passed it around her office – in Bombay or Tokyo or Prague.

My views are being shared with people around the world.

¹ For example, John Montroll, *Prehistoric Origami*,

Information Revolution

This is a cliché now, but the world is very different than it was. We, working in our narrow worlds, sort of know that, but I don't think many of us have really confronted this emotionally. It's not just that our children have different problems socially than we did, or that they can now blithely travel around the world without giving it a second thought.

What the above anecdotes have in common is their reflection of the fact that the world we live and work in is *fundamentally* different from what it was a hundred (or even fifty) years ago. This difference is evident in the way we work, what we do in our work, and the way our employers are organized. The modern era is all about *knowledge*.

In the Nineteenth Century, society moved from working primarily on farms and as single artisans producing products one at a time, to working in factories, producing hundreds or thousands of copies of a product at the same time. The driver of this new economy changed from land to capital. If you could accumulate enough capital to build a factory, the factory would produce wealth. The people who worked there simply carried out your instructions for making wealth.

Instructions were passed down an organizational hierarchy, and performance monitoring was passed up.

Karl Marx observed that the people who worked in these factories became alienated from their work. Divisions grew up between management on the one hand that wanted the most output for the least money, and labor on the other who wanted a living wage for their efforts.

In the last fifty years, things have changed again. Suddenly information is more important than physical capital. A company that is smarter in getting the most use out of a physical device will be more successful than one who is not. Marx's observations are no longer relevant because the relationships between labor and capital have fundamentally changed.

Microsoft is one of the most successful companies of all time, yet it produces virtually no physical product, and has relatively little physical capital. Oh, they do produce physical media, such as compact disks, but customers are not buying the media. They are buying the knowledge that is encoded on the media. Consider the microchip in your computer: The value of all the chips produced today exceeds the value of all steel produced.² What makes a chip so valuable? Certainly not its physical components. It is ultimately made of sand. The value is in the design of the chip and in the design of the complex machines that make it. The value is in its knowledge components.

Even companies that sell physical products, such as automobiles, have had to radically increase the intellectual content of their products. To compete, a car must now be made intelligently, economizing on weight, cleverly getting the engine not to emit harmful gasses, and providing just the right "feel". All these things come from the auto-maker's investment in knowledge and expertise, not from its investment in steel and rubber.

This change has had a profound effect on the nature of the workplace. Now most of us are "knowledge workers", not factory workers. Many of us no longer work for a "boss" who tells us what to do and makes sure that we do it to specification. We have become consultants, hired to assist our clients, using our expertise and knowledge. We tell the client what to do.

This means that our entire transaction with the client comes down to whether or not we are providing a useful service. Not only is the client free to let us go if he decides we are not being useful, but we probably want to go if the environment is not one where we can be productive. This is a much happier arrangement than the corporate world where we must be alert to politics and making the right people happy – in ways that have nothing to do with our skills or abilities.

Our motivation is no longer security and money. We work on projects because they stimulate our imagination and intellect. We will work for a company as long as it provides interesting projects. When it stops doing so, we will go somewhere else.

The study of knowledge is both very old and very new. Philosophers have been writing about it for millennia. But attention to the relationship of knowledge to the structure of the workplace is relatively new. A lot has been written about it to be sure, but most of this has been in the last ten years.

This paper is an attempt to collect some of the more salient observations that have been made about knowledge in the modern workplace. Because of the nature of the topic, it is somewhat random in its structure, but it is to be hoped that the reader will get an introduction to what is being discussed in various knowledge management circles.

The paper will cover the following topics:

- Kinds of knowledge – in general

² Thomas A. Stuart, *Intellectual Capital*, Doubleday/Currency, (New York: 1997), p. 13.

- Knowledge of what?
- From data to wisdom and all the steps in between
- Limits to what we can know
- Knowledge and companies
- Accounting doesn't cut it
- Kinds of capital

Kinds of Knowledge – in General

The coin of the realm, then, has become “knowledge”. This is an ancient concept that has taken on new meaning in recent years. What does it mean?

Knowledge is created, acquired and transmitted through generations from parents to children. Within organizations, knowledge is transferred from bosses to employees and vice versa, and among colleagues. The knowledge may be of techniques, procedures, events, rules, or navigation of the company itself.

What kinds of knowledge are important to an organization? At a simplified level, we can identify these:

- **Data** – As information professionals, we assume that the most important knowledge is that which is captured in our relational databases. We are merrily building data warehouses that purport to put all the information in the company at the management's fingertips.

This is only one part of the company's knowledge, however. It is confined to information about products, people, activities, and so forth, that are currently part of our environment. A data warehouse has little information about the future. What businesses should we be in instead?

- **Intellectual capital** – Buried more deeply in the company's archives are the results from its research and development. Here are the patents and copyrights. The drugs that were interesting ideas but which didn't pan out in curing the diseases for which they were intended. The ideas that looked promising but never came to fruition that time around.

Here we have a tremendous source of future growth and revenue. There is intellectual capital that the company already owns that it has been unable to exploit. For example, how many patents does your company hold that are filed away somewhere, forgotten? Can systems help here? Of course. Can systems solve the organizational problem of making it possible to use this capital in a constructive way. Probably not.

- **Expertise** – The third category of knowledge is the hardest of all to capture – the expertise of the company's employees. People know things about what works and what doesn't. A company with low turnover has a tremendous body of knowledge – if it can figure out how to exploit it. A company with high turnover is losing wealth every time someone leaves.

Knowledge of what?

So what is it that we want to know? Journalism can give us a clue. The traditional dimensions of any news story are “what?”, “how?”, “where?”, “who?”, “when”, and “why?” John Zachman has pointed out that these translate into the following:

- **Things of the business (What)** – What are the things of significance to the organization about which it wants to know something? What resources (physical and intellectual) exist?
- **Processes (How)** – What does the company do? What should it be doing? How does it work?
- **Distribution and geography (where)** – Where does the company do business? How do people, materials, money, and information travel from place to place?
- **The organization (who)** – What is the company's organization? This whole change in orientation towards knowledge management is having profound effects on the organization. What does this mean?
- **Events, agents, responses (when)** – What role does time play in the company's operations? What events cause things to happen? Who responds and in what ways?
- **Motivation and Business rules (why)** – What are the company's objectives, and how are they translated into business rules?

The company's body of knowledge is composed of all of these, mixed together in various ways. Some modeling techniques are available to address some of them, but no model has yet completely captured them all.

From Data to Wisdom and the Steps in Between

It is common to confuse data, information, and knowledge. People are beginning to tease apart definitions of each. Verna Allee has defined levels of knowing in terms of the first two categories described above: what is known, and how is it used. In each of these realms, she has then characterized the following:³

WHAT IS KNOWN?	HOW IS IT USED?
DATA (Instinctual learning) – the sensory or input level.	DATA (Feedback) – registering data without reflection.
INFORMATION (Single feedback loop learning) – data organized into categories	PROCEDURAL (Efficiency) – doing something the most efficient way. Conforming to standards or making simple adjustments to modifications. Focus is on developing and following procedures.
KNOWLEDGE (Behavior modification) – the interpretation of information by someone.	FUNCTIONAL (Effectiveness) – seeking effective action and resolution of inefficiencies. Evaluating or choosing between alternate paths. Focus is on work design and engineering aspects.
MEANING (Communal learning) – perception of concepts, relationships, and trends. From this perspective it is possible to detect relationships between components.	MANAGING (Productivity) – using conceptual frameworks to understand what promotes or impedes effectiveness. Effective management and allocation of resources and tasks, using conceptual frameworks to analyze and keep track of multiple variables.
PHILOSOPHY (Inquiring into our own thinking processes) – integrative or systemic understanding of dynamic relationships and non-linear processes, discerning patterns that connect. Recognizes the imbeddedness and interconnectedness of systems.	INTEGRATING (Optimization) – long-term planning and adaptation to a changing environment. This includes long-range forecasting, development of multi-level strategies, and evaluating investments and policies with regard to long-term success.
WISDOM (Generative learning) – learning for the joy of learning, involving creative processes, heuristic and open-ended explorations, and profound self-questioning.	RENEWING (Integrity) – Defining or reconnecting with values, vision, and mission. Understanding purpose.
UNION (Synergistic) – integration of direct experience and appreciation of oneness or deep connection with the greater cosmos. Requires processes that connect purpose to the health and well-being of the larger community and the environment.	UNION (Sustainability) – Commitment to the greater good of society, the environment, and the planet.

What does all this mean?

Imagine our data warehouse project. It begins with the collection and compilation of *data* from many sources. The process involves technology to bring the data from various places to a central place.

The data become *information* when they are presented in an organized fashion. A sales report, for example, or a customer complaints report, are information. Our data warehouse assignment is to present the information as efficiently as possible. Current procedures are being followed for dealing with complaints. Evaluations are in terms of their success in doing so.

³ Verna Allee, *The Knowledge Evolution: Expanding Organizational Intelligence*, Butterworth-Heinemann (Boston:1997), pages 67-68.

The sales and complaint data become *knowledge* when the process of handling complaints is examined and attempts are made to improve it. This affects the company's processes by stimulating efforts to make the customer complaints go down. The process of dealing with complaints is examined to see if it can be improved. We are looking for effective action.

By looking at the overall process of handling complaints, it is possible to divine the *meaning* of this procedural knowledge. How can we make the company more productive overall?

Are there patterns behind the complaints? What about the correlation between high levels of complaints and declining sales? What is there about the product, the way we sell it, and the way we use it that causes these complaints. The examination of *philosophy* is all about understanding patterns in the environment. Our response is to do long term planning to adapt to the environment, based on what we are able to figure out about it.

Is the company exhibiting *wisdom* in the way it pursues its values, vision, and mission? How compatible are those complaints (and sales levels) with our values, vision, and mission?

And finally, how does our company's behavior (in the resolution of complaints, for example) relate to the community at large? Are our products socially desirable. Are we furthering life or inhibiting it? Have we formed a *union* with our environment?

Too Much Knowledge?

Especially in our field, there is way too much to know. When I was new in the business, I could read *Computerworld* and not be bothered by the fact that most of it was a complete mystery to me. Know, most of the articles are on subjects that I am supposed to know something about. Indeed, I could know a lot about them if I only had time to pursue them. I find it extremely bothersome that I don't really.

How many books do you have on your bookcase that looked really interesting when you bought them, and you really do intend to read – but haven't had time to look at yet?

We, and all managers, are up against the *Law of Requisite Variety*, first described by H. Ross Ashby in 1956:⁴ *Only variety can destroy variety*. This means that if you wish to regulate a process, your variety must be equal to that of the process to be regulated.

Variety is a concept from information theory. It means simply the number of different states. A communication channel's capacity is expressed in terms of its variety. If it can transmit 56,000 bits per second, that is the total variety that can be communicated.

The problem is that each of us has a channel capacity. We can only absorb so many things. Interestingly enough, this is measured in terms of the number of discrete actions we can take. If we are only able to act in four ways, we are only capable of receiving four bits of information (variety). We deal with this by inventing amplifiers and attenuators for the variety. ("Attenuator" is an engineering word for "filter".) An exception report is an attenuator. A more common attenuator is our tendency to simply skim over large reports, with random facts reaching our consciousness. These techniques reduce the total variety of the original body of data. Going the other direction, a broadcast e-mail from the boss to his staff is an amplifier.

The Law of Requisite Variety was converted by Stafford Beer into three Principles of Organization. The first of these, and the only one that concerns us here is:

*Managerial, operational, and environmental varieties, diffusing through an institutional system, tend to equate; they should be designed to do so with minimal damage to people and to cost.*⁵

Our assignment, then, as information system designers, is not to present all data to our users, but rather to *design* attenuators so that our users only receive the information that they can absorb and use. We are supposed to be *reducing* the information presented, not increasing it. Absent design, an attenuator might be simply the fact that you can only absorb six numbers from the 200-page report. You can design an exception report to present the most important six numbers.

Our skills, then, are measured in terms of our ability to determine (or our providing a facility which can determine) *which* information is important.

⁴ W. Ross Ashby, *An Introduction to Cybernetics*, John Wiley and Sons (Science Editions), (New York: 1956).

⁵ Stafford Beer, *The Heart of Enterprise*, John Wiley and Sons (Chichester, UK: 1979), page 97.

Implications of Knowledge Management to Companies

New to the equation is the idea that we can *manage* knowledge itself. This entails “monitoring and improving knowledge by measuring and modifying the knowledge processes and their environment.”⁶

So how do you manage a knowledge-based company? Which is to say, how do you manage the knowledge of any company? First, you get rid of the organization chart. In the past your job was defined (and constrained by) who was above you and who was below you in the organizational hierarchy. Now it is defined by who you work with – wherever in the company (and in the world) those people are.

The “boss” is now irrelevant. In the old days, the boss told you what to do and instituted controls to make sure that you did that. Now, the boss may not even really understand what you do. His job is to make sure that you have what you need in order to do what you are to do. He supplies resources and then gets out of the way.

Knowledge is created “through the reconstruction of older concepts as well as the invention of new ones. Contrary to popular belief, knowledge is not discovered like diamonds or oil. It is constructed through concepts that we already have through observation of objects and events. And it only becomes knowledge when a person, group, or society validates the concept.”⁷

Knowledge management attempts to bring together technology-based repositories of codified information (the “supply-side” view) and knowledge-enabling environments, or *learning organizations* (the “demand-side” view). Knowledge processes are those intended to (1) produce knowledge, (2) acquire knowledge, and (3) transmit knowledge. Knowledge processes support other business processes by providing knowledge needed by agents to perform acts.

Good knowledge management means influencing knowledge processes within an organization so that goal-directed learning, innovation, and adaptive evolution can occur.

Accounting doesn't cut it

Companies are ultimately evaluated in financial terms. The double entry accounting system we use to account for a company's assets and liabilities was invented in 1494 by Luca Pacioli,⁸ in a world where everyone was either a farmer or shopkeeper. Aside from the addition of specialized reports such as balance sheets, income statements, and cost accounting, the scheme hasn't changed in 500 years.

The problem with it is that it only recognizes tangible assets – assets from the farming and later the industrial revolution days. It has no way to recognize a company's intellectual assets. “The components of cost in a product today are largely R&D, intellectual assets, and services. The old accounting system, which tells us the cost of material and labor, isn't applicable.”⁹

The effect of this is that companies are often sold for many times their book value – which is to say, for many times their physical assets – based on the perceived value of their intangible assets. On the books, this amount is listed as “good will”, but somehow that isn't really an adequate representation.

For example, in 1998, Berkshire Hathaway's net worth was \$57.4 billion, the largest of any American corporation. Berkshire Hathaway's market value, however, was only one third that of knowledge companies Microsoft and General Electric.¹⁰

Kinds of capital

Ok, so if the physical capital on the balance sheet isn't important any more, what is? Thomas Stephens lists three kinds of “intellectual capital”:¹¹

⁶ Ed Swanstrom, *What is Knowledge Management*, a book in process from John Wiley and Sons, 1998, p. 3.

⁷ *Ibid*, p. 3..

⁸ Luca Pacioli, *Summa de arithmetica, geometrica, proportioni, proportionalita*. (Venice: 1494).

⁹ Thomas A Stewart, *op. cit.*, page 59.

¹⁰ Berkshire Hathaway, *Annual Report*, 1998, page 4.

¹¹ Thomas Stewart, *op. cit.*

- **Human capital** – the value of the knowledge held by a company's employees.
- **Structural capital** – the physical means by which knowledge and experience can be shared.
- **Customer capital** – the value of the company's franchise and its ongoing relationships with its customers (and vendors).

Human Capital

A company always has much more knowledge and expertise than it realizes. Many companies are very poor at realizing and exploiting this. Traditional corporate organizations have often prevented companies from gaining full benefit from employees' knowledge. In the new world, this must change.

During the 19th century, the writings of Karl Marx and Charles Dickens gained currency because they described the fundamental problems of having people work as appendages to machinery. People didn't own the equipment they used. They were interchangeable. The jobs were narrow and boring. Unfortunately, because of the nature of the work to be done, this was the most economically attractive alternative, and it continued well into the twentieth century.

In the last fifty years or so, the value of the knowledge component of products has become recognized, and factory workers have become knowledge workers. Suddenly the tables have turned. Now the worker chooses what he works on and how he goes about it. Because the company is dependent upon his knowledge, it must permit this to happen. It is in the nature of knowledge that it is communal, so people are no longer working on isolated tasks. The working environment is becoming clusters of people who share an area of interest or an objective. Their motivation is in the work itself, not the benefits bestowed by the corporation.

Thomas Stewart describes the opinion of Frank Walker, president of GTW Corp, that there will ultimately be only four types of career:

- The top level sets strategy: It is the land of presidents and CEOs and executive VPs.
- Resource-providers develop and supply talent, money, and other resources; they are the CFOs and CIOs, human resources managers, temporary services firms, or heads of traditional functional departments like engineering and marketing.
- Project managers buy or lease resources from resource-providers – negotiating a budget and getting people assigned to the project – and put them to work.
- Talent: chemists, finance guys, salespeople, bakers, candlestick makers (and presumably the odd system developer or two).¹²

Managing in this environment is not easy – especially for people who only know the old capitalist approach.

Structural Capital

This is what we information technologists can deliver. This includes everything from the internet and Lotus notes, for sharing ideas and thoughts on various subjects, to data warehouses, which publish the operational data from the company. Companies, like Wal-Mart, that are successful in building their structural capital are very successful in the marketplace.

Ok, so what does all this mean to those of us that build systems? Knowledge management can be divided into two topics: Natural knowledge management and artificial knowledge management. Natural knowledge management is concerned with the way people learn and communicate with each other. It is, for the most part, not concerned with technology. Artificial knowledge management is all about information processing using technological tools. As we address artificial knowledge management, we must keep in mind three things:

We must understand the role of systems

Systems don't create knowledge; they manipulate data and turn them into information. System design will make it easier or harder for users to take the next step and turn information into knowledge. The decision to build particular systems should be based on the meaning, philosophical and wisdom levels of understanding.

We must design systems to support knowledge management (filter variety)

The job is not to push out more data. The job is to allow a user to naturally retrieve the right data. This requires skill in designing data and the user interface. This is the fundamental criterion we must apply in designing our data marts: are they presenting the right amount of the right data for the user to make decisions? (Does the variety of the presentation match the variety of the user?)

¹² *Ibid.*, page 204.

We must expand the domain of our systems to include “fuzzier” data.

This includes not only compiling data in databases about such things as patents and trademarks, but also making available better communications tools, so that people can work together on projects, even if they are not physically in the same place. This is particularly true of research kinds of projects where the process is one of pure intellectual exploration. Also important is the need to capture the results of knowledge creation in meaningful, accessible ways. Electronic mail and products such as Lotus Notes have taken us a long way in this direction.

Customer Capital

In the days of smoke-stack capitalism, the economy consisted of factories producing thousands of copies of the same thing. Marketing consisted of persuading lots of people that that thing was exactly what they wanted. The customer was at the mercy of the producer.

Now, the balance of power is devolving onto the customer. Customers expect tailor-made products. (Land’s End just published an ad for swimsuits that are designed precisely for your shape.) This means that the company’s relationship to the customer – its ability to clearly understand what the customer wants – is critical. Companies that have established such relationships are worth a great deal more than companies which have not. But these relationships show up nowhere on the books.

Conclusion

My son is an undergraduate student studying philosophy. When I told him that I was looking into the field of knowledge management as it applies to corporations, he laughed. We’ll see . . .

About the Author

A thirty year veteran of the Information Industry, Dave Hay has been producing data models to support strategic information planning and requirements planning for nearly twelve years. He has worked in a variety of industries, including, among others, power generation, clinical pharmaceutical research, oil refining, forestry, and broadcast. He is President of Essential Strategies, Inc., a consulting firm dedicated to helping clients define corporate information architecture, identify requirements, and plan strategies for the implementation of new systems. He is the author of the book, *Data Model Patterns: Conventions of Thought*, recently published by Dorset House, and producer of *Data Model Patterns: Data Architecture in a Box*, an Oracle Designer repository containing his model templates.

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